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RADIOACTIVE WASTE DISPOSAL

A Bibliography of Unclassified Literature

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Radioactive Waste Disposal
A Bibliography of Unclassified Literature

compiled by
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INTRODUCTION

This bibliography of unclassified references to radioactive waste disposal was compiled in response to a specific request. It is a highly selected bibliography and does not attempt to cover all references to the subject.

Although most of the work on this problem is classified, much information of a general, practical, and specific nature has been released.

The purpose of the bibliography is to provide a source of information on various processes and methods of radioactive waste disposal. These methods can be categorized as follows:

A. Dilution and release into sewage systems and waterways where bacterial action eliminates radioactivity hazards

B. Neutralization before release into sewage systems

C. Concentration and storage

D. Incineration

E. Dilution of radioactive gases into the atmosphere.

References to laboratory equipment other than waste disposal systems are incidental.

It is believed that the information contained in these references will provide suitable background information and will aid in establishing criteria in the safe handling of radioactive wastes.

I LIQUID WASTE DISPOSAL - GENERAL

1 Radioactive Waste Disposal. John A. Ayres. nd. 25p. AECD-2802.

In laboratories using radioactive tracers a large amount of liquid wastes having a low level of activity will be produced. In many cases it may be desirable to treat these wastes before they are discharged into the sewers or released in any other manner into the ground or water. Ion exchange is applicable to problems of this sort in that it may be used for the removal of small amounts of ions from very dilute solutions. The problem of removal of radioactive solids from laboratory wastes is complicated by the fact that the wastes are heterogeneous and vary from day to day. The wastes will contain solids, organic solvents, oils, and reagents which may form complexes with metallic ions. The research program to evaluate ion exchange has been divided into several parts, namely: (1) the efficiency of ion exchange resins for this type of process; (2) determination of operating curves under set conditions for typical types of ions; (3) determination of amount of leakage or efficiency of ion exchange resin in order to estimate decontamination factors; (4) effect of reagents which might cause precipitation or complexing; (5) effect of solvents, greases, detergents, or precipitates; (6) possible concentration by incineration. Two procedures, complete de-ionization and partial de-ionization, are described. Experimental evidence was obtained to show: (a) a high decontamination factor may be obtained using synthetic solutions which represent laboratory conditions; (b) a high concentration factor may be obtained making possible the compacting of the wastes into small volumes; (c) the presence of ordinary contaminants such as oils, solvents, and precipitates do not have a great deleterious effect.

2 Health Physics Division Quarterly Progress Report for Period Ending April 15, 1950. K. Z. Morgan and F. Western. May 26, 1950. 23p. ORNL-695.

Activities of those groups primarily engaged in applied research or development are briefly reported. Instrument Development: fast neutron program, portable α survey meter, constant water monitoring, and β dosimeter. Waste Disposal Studies: water and liquid waste decontamination processes, survey studies of White Oak drainage system and Clinch River, instrumentation, and miscellaneous. Theoretical Physics: ionization and excitation losses of charged particles traversing matter, interpretation of cross section data, and fast neutron problem in tissue. Experimental Physics: radium analysis apparatus, stack gas dispersal studies, and instrumentation for aerial uranium prospecting. Special Problems: surface dose of uranium, backscattering of β particles with an extrapolation chamber, backscatterer measured with β counter filled with argon and methane, absorption of β particles, and neutron monitoring, Urinalysis: analysis for radioactive strontium and method for removing impurities from lanthanum. Education and Training: AEC Fellowship program.

3 Digest of Proceedings, Seminar on the Disposal of Radioactive Wastes, Sponsored by the Atomic Energy Commission, January 24-25, 1949. Press Release No. 154.

The seminar was opened with a discussion of general background information about radioactivity units for measuring radiation and permissible limits. The invited speakers from the AEC installations, other Government agencies, universities and industry presented papers on the following subjects:

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Radioisotopes- Production, Distribution Use and Control; Health Problems in Atomic Energy Activities; Processes Used in Nuclear Fission Operations; Operations at AEC Plants Which Create Waste Disposal Problems; Radioactive Waste and Disposal; Health Problems Related to Disposal of Wastes; and Appraisal of the Sanitary Engineering Aspects of Atomic Energy Development.

4 Safe Disposal of Radioactive Wastes Demands Special Training for Sanitary Engineers by Arthur E. Gorman Civil Eng. 19 No. 3 29-32(1949) March.

The answers to some of the problems of radioactive waste disposal encountered by the Atomic Energy Commission are discussed. Different methods of disposal, applicable to the different types of wastes produced, are described. The author stresses the need for sanitary engineers with the necessary training in nuclear physics to carry on such work at the various atomic energy installations.

5 Radioactivity--A New Factor in Water Works Practice. Arthur E. Gorman. J. Am. Water Works Assoc. 41, 1053-60(1949) Dec.

The author briefly discusses the different types of radiation and their effects on living tissue. He then describes work now in progress to safeguard water supplies from contamination by radioactive wastes and to establish tolerance limits for concentrations of activity in air and water. It is concluded that water works and public-health officials will have to acquaint themselves with the fundamentals of nuclear physics and with the techniques of radiation measurements in order to deal with the problem of radioactive contamination in the future.

6 Learning to Live with Atomic Radiation --A Challenge to Engineering Profession. Arthur E. Gorman. Civil Eng. 19, 28-9(1949) Dec.

The author discusses the research work which is being carried on in the disposal of radioactive wastes and how the Atomic Energy Commission is cooperating with the other agencies in solving this problem. The need for including courses in nuclear physics in engineering curricula is briefly presented.

7 Nuclear Fission Developments Pose Sanitary-Engineering Challenge Eng News-Record 141 No. 16 91-92(1948) Oct. 14

The role of the sanitary engineer in protecting man and his environment against hazards of radioactivity was discussed by Abel Wolman and Arthur E. Gorman at a recent meeting. Particular emphasis should be placed by sanitary engineers on groundwater protection, disposal of radioactive wastes, sewers and pipes, and problems of water supply and disposal.

8 Research on the Disposal of Radioactive Wastes. O. R. Placak and R. J. Morton. J. Am. Water Works Assoc. 42, 135-42(1950) Feb.

The problems involved in radioactive waste disposal are discussed in general terms. The natural activities of several water sources are tabulated, and it is noted that natural activities are in some cases higher than the activity in Clinch River, below the Oak Ridge plant. The author then describes work now in progress to determine maximum permissible concentrations of radioactive materials, and the maximum

permissible concentrations of various materials in various organs of the human body are tabulated. The general program that has been set up by several agencies to study the problem of radioactive waste disposal is described.

9 Radioactive Waste Disposal--How Will It Affect Man's Economy? Kenneth G. Scott. Nucleonics 6, 18-25(1950) Jan.

The author describes the waste disposal problem faced by the growing number of public institutions, such as the University of California Medical Center for example, which use radioactive isotopes. Such wastes cannot be eliminated through sewage systems because of the high radioactive concentrations which would result in the sewage filter cake which is often used for fertilizer. The disposal methods recommended by the AEC are: dispersion in media such as air or water, confinement and dilution in materials such as concrete, or confinement in storage tanks after the volume of the waste has been reduced. These different methods are compared, and the disposal of wastes in the oceans is discussed in some detail.

10 Problems of Radioactive Waste Disposal by Forrest Western. Nucleonics 3, No. 2, p. 43-49, Aug. 1948.

The nature of the waste disposal problem as well as the general principles by which the problem may eventually be solved are mentioned. The possibilities of disposal are: (1) Dilution, where care must be taken that the radioactive chemicals do not become concentrated by absorption or adsorption. (2) Dilution by mixing with one or more stable isotopes of the same chemical element. (3) Storage to allow decay to stable isotopes. (4) Concentration of radioactive materials by removal from process fluids by ion exchange, adsorption, precipitation, sedimentation, extraction, and evaporation. (5) Placing in containers and disposal of materials in the ocean. Tables are given of tolerance concentrations of various radioisotopes in drinking water, decay time of some fission products, and activities of certain long-life fission products in pile after 100 days.

11 Radioactive Sewage. Discovery 11, 186-9(1950) June.

Nine photographs illustrating the disposal of waste water from the Harwell pile are shown.

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12 Effect of Beryllium Compounds on Sewage Effluents and Streams. M. M. Luckens. Jan. 1949. 46p. AECU-221.

This report presents a survey of the literature of beryllium compounds which may be expected in sewage effluents and streams. The probable effect of beryllium compounds on sewage and water courses is discussed in the light of the data in the literature and the findings of this laboratory. Normal compounds of beryllium in aqueous solution do not exist in the region of neutrality. These compounds in solution, therefore, should be treated as acid or alkaline wastes, depending upon the conditions. In view of the commercial value of beryllium oxide, it might be economically feasible to precipitate the hydroxide out of the effluent before discharge into the receiving body of water. This would reduce the health hazard as well as the possibility of detrimental effects on the stream. It was found experimentally that

beryllium hydroxide, and possibly beryllate ion, caused an appreciable depression in the dissolved oxygen content of Theriault-Nichols dilution water and sewage dilutions as determined by the azide modification of the Winkler method. The high acidity of beryllium sulfate solutions prevented the determination of dissolved oxygen by standard methods. The determination of the dissolved oxygen of sewage effluents or dilution waters containing beryllium compounds calls for the development of a special method of analysis. Effects of beryllium wastes on microorganisms and bacteria are discussed in relation to the possible resulting lack of effect of bacteria on radioactive wastes should they be discharged in the same sewage.

13 The Removal of Plutonium from Laboratory Wastes. C. W. Christenson, M. B. Ettinger, Gordon G. Robeck, E. R. Hermann, K. C. Kohr, and J. F. Newell. nd. 2p. AECU-836.

The document is in abstract form; it is reproduced below in its entirety.

A study of the removal of plutonium from laboratory wastes was undertaken in order to obtain information upon which to base pilot plant design. The methods investigated have included: (1) co-precipitation with iron, aluminum, and other metal ions. (2) adsorption by various agents such as activated carbon, "Celite," kaolin, etc., and (3) removal by living biological floc (activated sludges).

The activated sludge process was indicated to require a three-stage countercurrent plant with the addition of organic food sources ahead of each stage in order to reduce the plutonium content of the effluent to the desired level. The adsorption agents studied all removed plutonium with a fairly high degree of efficiency, activated carbon being the best of a number of materials studied. Effective adsorption was found to require a protracted period of contact. In order to obtain the desired plutonium removal without creating a new problem in the form of a large amount of contaminated adsorption agent, split treatment with long periods of mechanical agitation was indicated as being required.

In the absence of substantial amounts of organic complexing agents, the co-precipitation treatment appeared to be the simplest, cheapest, and most efficient. Because its efficiency was less subject to variation at different pH values, an iron floc was deemed to be preferable to an alum floc. The amount of iron required for the treatment was quite nominal, 10 ppm of $FeCl_3$ with sufficient lime added to bring the pH above 7 being adequate to produce the desired plutonium removal.

An occasional grab sample of waste was found which did not respond to the treatment with iron and lime outlined above. However, these were rare, and it was evident that the interfering materials in these samples would be diluted to innocuous levels by equalizing tanks. Samples composited from multiple grab samples were invariably treated successfully.

14 Laboratory Studies on the Removal of Plutonium From Laundry Wastes. John F. Newell, C. W. Christenson, J. D. Shaykin, H. L. Krieger, D. W. Moeller, and C. C. Ruchhoft. nd. 2p. AECU-837.

The document is in abstract form; it is reproduced below in its entirety.

Studies were made on the treatment of wastes from the laundry for contaminated clothing at Los Alamos. The wastes contained soap, synthetic detergents, citric acid, and lint.

The five-day B.O.D.'s (biochemical oxygen demand) of the wastes varied from about 200 to 600 ppm. The alpha activity from plutonium was relatively low, averaging about 1500 cts/min/liter, but maxima of 20,000 cts/min/liter were observed. The objective in treatment was to reduce the plutonium activity in the discharged effluent to 70 cts/min/liter or less. A reduction in the B.O.D. was desirable but of secondary importance. Preliminary experiments indicated that either biological or chemical treatment could be used to remove the plutonium from the waste. Chemical treatment (carrier precipitation) might not be entirely successful because of coagulation difficulties caused by complexing agents. Because of excessive foaming, activated sludge treatment was not feasible on detergent wastes.

Single stage pilot trickling filter studies were initiated in the summer of 1949. A second stage filter was added later and the two-stage filter has been operated with recirculation ratios varying from $2/1$ to as high as $30/1$. Since the waste was deficient in biological nutrients, additions of ammonia and phosphate were made to the laundry waste prior to biological treatment.

Laboratory scale chemical coagulation experiments were made in parallel with the biological treatment. Alum would not always produce a floc. Ferric chloride generally did not produce a settleable floc at pH values less than 11.5. Generally, satisfactory plutonium removal was obtained by chemical precipitation with calcium chloride, lime, sodium hydroxide, activated silica, and ferric chloride added in sequence at pH values of 11.5 or higher.

The trickling filter was ineffective in B.O.D. or plutonium removal with recirculation ratios of $8/1$ or less. With recirculation ratios of $15/1$ and higher, analytical results indicated nitrification, 90% or more B.O.D. removal, and satisfactory plutonium removal. Optimum recirculation ratios, nitrogen, and phosphorus requirements, and the disposal of sludge remain to be studied. The work indicates that the plutonium removal objective can be attained either chemically or biologically. Simplicity of operation and volume of sludge to be disposed of seem to favor biological treatment. (auth)

15 Exploratory Studies on the Removal of Plutonium From Liquid Wastes by Activated Sludge. John F. Newell. nd. 8p. AECD-2712.

Characteristics of wastes from the nuclear energy industry and the selection of an exploratory study program are considered. The discussion in this paper is limited to the activated sludge process. An ultimate goal of one thousandth of a μg (one-billionth of a g)/1 was tentatively selected as the maximum desirable concentration of Pu^{239} in waste solutions after treatment. This quantity is about one-tenth of the tolerance which has been tentatively established for the plutonium in drinking water. One $\mu g/1$ is one part per billion and for the material under consideration is equivalent to about 70,000 counts/min/1. One thousandth of a $\mu g/1$ is one part per trillion and is registered on the counting equipment as about 70 counts/min/1. Exploratory work indicated that the biological adsorptive material present in activated sludge will remove from 90-95% of tracer quantities of Pu^{239} from aqueous waste solutions. The radioactive material was removed from the solution and concentrated into the sludge. The level of radioactivity was built up to high levels in the sludge without affecting the biological process. Because of the high radioactivity of the waste sludge special safety precautions were used in its handling and disposition. Because of the high

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concentration of radioactivity in the sludge, unfiltered samples showed as high as 28% carry-over of radioactivity by suspended matter in the effluent. This suggests final treatment of effluent by filtration to assure the effectiveness of the process.

16 Studies of the Absorption and Assimilation of Radioactive Wastes by Bacterial Slimes on Surfaces by George W. Reid, Johns Hopkins University, February 15, 1950. 10p. JHUX-1.

This report is the first of a series of work undertaken by the Johns Hopkins University to conduct and expand research and training programs in the field of sanitary engineering aspects of radioactive waste problems. Research includes studies of the absorption and assimilation of radioactive wastes by bacterial slimes on surfaces of pipes, stream beds and other substitutes. Surfaces in contact with water become coated with films of slime forming bacteria. These slimes possibly will determine concentration and distribution of radioactive wastes. Sampling and counting techniques are described.

17 Studies of the Absorption and Assimilation of Radioactive Wastes by Surface Bacterial Slimes by George W. Reid and Dale W. Moeller. 13p. May 15, 1949. JHUX-2.

A procedure has been set up for testing the slimes for the adsorption of radioactivity.

Phosphorus^{32} and I^{131} have been selected as the radioactive isotopes for these tests. P^{32} is being used first.

There are two reasons for the selection of these isotopes; (1) they are the ones most widely used in hospitals and research laboratories and are consequently the ones most likely to be encountered by the Sanitary Engineer, and (2) phosphorus is a major metabolite of slimes; iodine, much less so. It is hoped that the possible differences in behavior of these two elements will give an indication as to the behavior of the two different types of isotopes as related to adsorption and of slime films metabolism. It is felt that the presence or absence of an element normal to the cell structure or mucoid matrix of slime would have considerable bearing on the isotopic exchange rate and the consequent advisability of isotopic dilution. The project has been divided into laboratory and field activities. Laboratory produced slimes will be used as well as slimes grown naturally in laboratory sinks, that have been subjected to the disposal of radioactive phosphorus. In the laboratory, special emphasis will be placed on the effect of varying contact time and specific activity on the phosphorus uptake. By controlling the pH, and the stable phosphorus concentration ratios in the growing media and measuring correlated changes in the slime itself, information can be obtained on the assimilation and exchange phenomena. The field investigations, on the other hand, represent actual conditions.

The activity levels under study are within the range of the allowable levels established for radioisotope disposal by dilution of the Interim Recommendations, Atomic Energy Commission, 1949.

18 (Studies on the Uptake of P^{32} by Bacterial Slimes) Informal Progress Report for May 15, 1949 - October 1, 1949 by George W. Reid, Dale W. Moeller, Albert Talboys and Irvin Grossman. 43p. JHUX-3.

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The uptake of radiophosphorus (P^{32}) by bacterial slimes similar to those commonly developed in traps, sinks, and drains has been studied. Estimates have been made of the efficiencies of uptake and of the hazards represented. The relative significance of metabolic uptake of P^{32} and of simple adsorption has been determined. This laboratory study has been supplemented by field examinations which support experimental findings.

The report includes observations upon the release of radio phosphorus from P^{32} bearing slimes. The effects of simple rinsing, high and low pH rinses, soapy waters, chlorine and other chemicals have been examined.

A study of the uptake of P^{32} by various bare metallic surfaces has been partly completed. A pilot plant and model sewerage system for the study of uptake and release of P^{32} in wastes under normal discharge and flow conditions is under construction.

Studies on the uptake of radioiodine (I^{131}) by bacterial slimes are now in progress.

The findings from the investigations completed, and which are now in progress, should be of value in developing methods for the safe disposal of radioactive laboratory wastes.

19 Disposal of Radioactive Wastes from the Massachusetts General Hospital by Frank A. Butrino, Massachusetts Institute of Technology. May 19, 1950. 49p. NP-1623.

This document is a thesis submitted by the author for the degree of Master of Science. Investigations were limited to disposal of I^{131}, C^{14} and P^{32} and their effects on the general sewage system in the Boston Area. The thesis discusses radioactivity in general, with emphasis on health hazards and waste disposal. Experimental counting and sampling techniques are covered followed by recommendations particularly regarding disposal of I^{131}. Dilution and reduced concentration before entering the sewage system to be accomplished on days when hospital laundry is in operation.

20 Biochemical Oxygen Demand of Sewage and Standardization of Laboratory Procedures by Werner N. Grune and Mark M. Luckens, New York University. Sept. 16, 1949. 51p. NYOO-1500.

Many industrial wastes, when discharged into sewers in concentrations high enough to be toxic to bacteria and other microorganism, will interfere with the biochemical oxidation processes. Radioactive wastes are part of the discharge and studies have been undertaken to determine the effect the radiation will have on bacteria. This report, the first part of a series presents research objectives and outlines experimental procedures in carrying out this program.

21 Calculation and Statistical Analysis of the Biochemical Oxygen Demand Velocity Constant. Werner N. Grune. Nov. 1949. 40p. NYOO-1501.

The Biochemical Oxygen Demand (B.O.D.) of sewage and organic wastes is very distinctly described by a reaction velocity constant. In this approach the sanitary engineer has applied the chemist's tool of a unimolecular reaction to which the B.O.D. very closely conforms. Several factors that influence the value of this velocity constant have been treated statistically in this progress report in order to gain a better understanding of it for further experimentation and research. The foundation for the evaluation of the effect of radioisotopes on domestic sewage has now been completed, and the addition of isotopes can proceed. 13 references. (auth)

II LIQUID WASTE DISPOSAL - BIOLOGICAL METHODS

22 Biochemical Oxygen Demands of Radioactive Sewage (Progress Report) Rolf Eliassen, Werner N. Grune, Theodore Jaffe, and A. N. Diachishin. Mar. 1950. 77p. NYOO-1510.

In this report the first findings of the effect of radioactivity on sewage are reported. Thus far, no real significance can be attached to these findings, pending further investigations and additional laboratory runs. Under investigation and reported herein are the reaction rate constant of the biochemical oxygen demand of sewages, the dilution water used for this purpose, nitrification, and both first- and second-stage observations, all compared to the possible effect that radioactivity might have on these when discharged as a waste product. P^{32} was used as the source of radioactivity in these experiments. (auth)

23 Disposal of Radioactive Wastes by Biological Methods. I.C.C. Ruchhoft. Atomics 1, 12-15(1949) Aug.

Reasons are given for preferring the activated sludge process to the trickling filter process in applying biological techniques to radioactive problems. The principles governing the sludge process are outlined, with emphasis on the important part played by zoogloeal bacteria. In experiments on Pu solutions it was found that sludge treatment for 24 hr reduced the activity in the liquid from $\sim 10^5$ c/min/liter to $\sim$4,000 c/min/liter. (auth)

III SOLID WASTE DISPOSAL - INCINERATION

24 The Development of a Destructor for Processing Solid Combustible Radioactively Contaminated Waste. F. T. Crego, W. B. Moen, C. J. Sullivan, and A. Muller. Apr. 1950. 56p. ARSC-31.

The design, construction, and testing of an experimental destructor for processing solid combustible waste contaminated with radioactive materials is described and discussed. Three units have been built, and the factors and considerations leading to the final design are outlined. Oxygen has been used for combustion to minimize the volume of combustion products and to accelerate the burning rate. A burning rate of approximately 20 lb/hr of cellulose has been realized with an oxygen input of 400 cfh, with efficiency of oxygen utilization considerably exceeding early estimates. Methods for processing the gaseous combustion products of the destructor, in order to dead-end these products by absorption and condensation, are discussed. A sulfur afterburner has been chosen as the safest and most effective means of converting residual oxygen to absorbable sulfur dioxide. (auth)

25 Supplemental Report on the Development of a Destructive for Processing Solid Combustible Radioactively Contaminated Waste by F. T. Crego, W. B. Moen, C. J. Sullivan, A. Muller. June 15, 1950. 17p. ARSC-32.

Additional data relative to the use of a sulfur after-burner for removing residual oxygen from destructive off-gas; alternate methods of processing flue gas; discussion of the monoethanolamine system.

IV DESIGN OF LABORATORIES - WASTE DISPOSAL SYSTEMS

26 The Architectural Approach to Radiochemical Laboratory Design by A. D. Mackintosh. Apr. 13, 1949. 35p. AECU-210.

IV DESIGN OF LABORATORIES - WASTE DISPOSAL SYSTEMS

The subject is introduced by showing how a newly specialized field of architecture has opened which must be approached with revised concepts. General planning and layout is discussed, with thought given to various levels of radioactivity. It is pointed out that a modular system must be adhered to, in order to effect flexibility. Means to implement modular flexibility are described, as well as surface treatment, and decontaminability. Service supply, including heating and ventilating, is discussed in modular terms, as well as equipment of a permanent and semi-permanent nature. Waste disposal facilities are then touched upon: gaseous, liquid, and solid. The conclusion reached is that flexible space of a "universal" nature must be provided, as well as a standardized design for equipment to be used therein.

27 Design of Laboratories For the Safe Handling of Radioisotopes by Myron B. Hawkins, USAEC Isotope Division, 31p. IDB-5.

A general paper on overall problems in designing and equipping laboratories handling radioisotopes. Ventilation systems, remote control handling apparatus and waste disposal is discussed. Waste disposal considered by incinerators, burying in tanks and ordinary sewage disposal. Concentration and deletion of wastes are solutions also offered.

V HANDLING RADIOACTIVE WASTES - RULES AND PROCEDURES

28 Rules and Procedures Concerning Radioactive Substances and Associated Hazards. U. S. Atomic Energy Commission, Clinton Laboratories, February 1947. 30p. MDDC-247.

The presently accepted rules and procedures which are considered necessary for the safe conduct of operations at the plant site are made available in this report. Topics covered are tolerance; radiation monitoring; protective clothing and devices; eating and smoking rules; contamination of persons; contamination of areas; storage handling and disposal of radioactive materials; and summary of enforcement responsibilities.

29 Review of Water Monitoring Procedures at Clinton Laboratories by H. M. Parker. 11p. MDDC-401.

The water monitoring procedures at Clinton Laboratories are reviewed from the standpoint of measurement of β ray dose, experimental standard, correction to the "tolerance water," measurement of gamma-ray dose, relation of β and γ activity, hazard of ingestion relative to external radiation, disposition of activity after release from the holdups ponds, preliminary suggestions for revised procedures, β ray dosage, and gamma-ray dosage.

Calculations and equations are given for determining the standards that have been established.

30 Counter Instrumentation and Measurement of Radioactivity by Werner M. Grune, New York University, March 1, 1949. 40p. NYO-2.

Techniques for measuring radioactive wastes are discussed, describes instruments and equipment necessary. Points out that this procedure is necessary in order that tolerance limits will not be exceeded which would interfere with biochemical processes in neutralizing and destroying sewage.

V HANDLING RADIOACTIVE WASTES - RULES AND PROCEDURES

31 Interim Recommendations for the Disposal of Radioactive Wastes by Off-Commission Users. Isotopes Division Circular. nd. 10p. IDB-6.

Basic considerations on disposal of radioactive wastes by dilution and dispersion, and by confinement and control are reviewed. Procedures are recommended for disposal of I^{131}, P^{32}, and C^{14}. Consideration is given to means for disposing of any type of radioisotope.

32 Handling Radioactive Wastes in the Atomic Energy Program, United States Atomic Energy Commission. Oct. 1949. 30p. GPO, 15¢.

This report describes radioactive waste materials, their sources in the atomic energy program, and the methods used in processing and storing or disposing of them at atomic energy installations and at laboratories and hospitals using radioisotopes. The first section on the meaning of radioactivity is followed by sections on types and sources of wastes and a section which describes various methods of waste disposal.

33 Safe Handling of Radioactive Isotopes, Handbook 42, U. S. Department of Commerce, National Bureau of Standards, Sept. 1949. 30p. GPO, 15¢.

This Handbook, prepared by the Subcommittee of the Handling of Radioactive Isotopes and Fission Products gives general recommendations suitable for typical laboratory or small industrial operations regarding safe handling of radioisotopes. It contains sections on proper instruction of personnel, principles underlying protective measures, laboratory design and equipment, including ventilation and waste disposal. Emphasis on the hazards of radioactive materials and monitoring necessary to detect over-exposure. Appendices contain a list of publications of interest to Radioisotope Laboratories.

34 Precautions When Using Radioactive Isotopes, The National Research Council of Canada, Aug. 29, 1947. 4p. HRAC-34.

Describes damages of radiation and health hazards encountered in isotope use. Laboratory techniques and waste disposal methods are discussed.

35 Protective Precautions in the Handling of Radioactive Materials by G. William Morgan [In "Proceedings of the Auburn Conference on the Use of Radioactive Isotopes in Agricultural Research, Dec. 18-20, 1947," Auburn, The Alabama Polytechnic Institute 54-69(1948)].

This comprehensive and compact paper contains discussions of the following topics: medical examinations for prospective radioisotope workers, planning a radioisotope laboratory, shielding, personnel monitoring, safe practices, selection of experimental apparatus, planning and monitoring operations, surveying areas for contamination, decontamination, and disposal of radioactive materials.

36 Hazards to Physicians, Patients, Nurses, and Others from use of Radioactive Isotopes. W. Edward Chamberlain, R. R. Newell, Lauriston Taylor, and Harold Wyckoff. Am. J. Roentgenol. Radium Therapy 61, 726-8(1949) May.

V HANDLING RADIOACTIVE WASTES - RULES AND PROCEDURES

A discussion of the problem of radiation injury is presented. The authors stress the fact that there is no antidote for radiation injury, so particular caution must be practiced on the part of the operator to prevent injury to the patient and to himself. The various types of external and internal irradiation are also mentioned. Patients' hazards mostly arise from errors by the physicians in calculation intensity doses. Wet and dry isotopic-containing wastes have to be disposed of by collection and isolation (deep burial, etc.) rather than dilution and distribution, because of the ability of some algae and other plant forms for re-concentrating these materials. A table is included which lists the hazards from radioactive isotopes, which may be used as a guide for the adequate control of these materials by physicians.

37 Health Physics by R. E. Lapp and H. L. Andrews. Nucleonics 3, No. 3, p. 60-67, September 1948.

This is a brief summary of the principal phases of radiation health protection, dealing principally with the biological effects of radioactivity. The discussion embraces a consideration of permissible levels of radiation exposure and the role of the health physicist. Other topics covered radiation hazards, absorption of radiation by tissue, radiation units and dosages, and waste disposal. 29 references.

VI RADIOACTIVE ISOTOPES IN HOSPITALS AND MEDICAL PROGRAMS

38 Preventive Medicine in the Atomic Age by W. C. Cox. Bull. U. S. Army Med. Dept. 8, 862-876(1948) Nov.

This is a general treatment of preventive medicine. In the section on radioactive isotopes the problems of the preventive medical officer and the health physicist of the communities in which radioactive isotopes are used are given as the (1) reasonableness of the radioactive isotope research, (2) provisions for the safe handling of the radioactive material, (3) health protection of the workers, (4) methods of storage of the radioactive material, (5) methods of waste disposal, (6) safety methods used in shipment of radioactive materials, and (7) provisions for replacement, periodic, and terminal health examinations of the workers and the records of daily and total exposure to radioactive substances. Provided that waste disposal is conducted in a satisfactory manner, the presence of a plant using radioactive isotopes is of no danger to a community.

39 Planning the Radioisotope Program in the Hospital. Edith H. Quimby and Carl B. Braestrup. Am. J. Roentgenol. Radium Therapy 63, 6-12(1950) Jan.

A summarization is presented concerning the most essential information necessary for establishing a radioisotope program in a hospital; reference is made to a number of pamphlets concerning special phases of the problem and in- and including cost lists for the essential equipment. A table is presented which lists the most important isotopes and compares their half-lives, maximum energy and other essential data. Laboratory facilities and equipment, shower and dressing room facilities, costs of an isotope laboratory, waste disposal, and the method of applying for radioisotope procurement are among the topics discussed.

VI RADIOACTIVE ISOTOPES IN HOSPITALS AND MEDICAL PROGRAMS

40 Certain Considerations in the Application of Isotopes to Medical Problems by DeWitt Stetten, Jr. Bulletin of the New York Academy of Medicine 24, p. 300-307, May 1948.

The properties and availability of stable and radioactive isotopes are briefly considered. Methods of handling, hazards, and waste disposal in so far as radioactive isotopes are concerned are also discussed.

41 Medical Program of the Atomic Energy Commission by Shields Warren. J. Amer. Med. Assoc. 138, 1227-1228(1948) Dec. 25.

The medical program of the Atomic Energy Commission may be divided into 5 parts: (1) the maintenance of health of the workers of the commission and its contractors; (2) protection of environmental health through proper waste disposal and avoidance of contaminating surrounding areas; (3) the development of basic research in the effects of ionizing radiation on the plant, animal and human cell, both isolated and aggregated; (4) the exploration of what, if any, values the new sources of energy available at the installations of the Atomic Energy Commission themselves and the value that very short-lived radioactive isotopes may have in cancer research and cancer therapy; and (5) development of a training program for scientific personnel.

42 Atomic Energy in Clinical Medicine. II. Protection Against Radiation. Ars. Med. 5, 358-71(1950) May (in French).

This article reviews the inherent dangers in working at the various atomic energy installations in the United States and the precautionary measures taken to protect the workers. Some of the topics discussed are monitoring of the atmosphere, waste disposal, personnel and area monitoring, and plutonium and beryllium poisoning.

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43 Characteristics of Mixing and the Dilution of Waste Stack Gases in the Atmosphere by P. E. Church, C. A. Gosline, Jr. 16p. MDDC-73.

A study has been made of the general characteristics of mixing and the amount of dilution that waste stack gases would experience when discharged into the atmosphere. It was assumed that such was dependent upon the meteorological conditions. Hence, for the experimental work, a 16-inch stack, 200 ft high, was erected through which, by means of blowers, the whole discharge of an Army M-1 'smoke', (oil-fog) generator was ejected into the air. The stack was provided with 1-¼ inch outlets at each 50 ft interval (up to 150 ft) through which came enough smoke to act as tracers for air flow at the various altitudes. These jet pipes extended outward 3 ft, from the stack; from each jet and at 200 ft a shielded thermocouple was suspended and connected to a precision potentiometer in the nearby office building. Recording anemometers were placed at 16, and 60 ft and a recording anemometer and wind vane at 200 ft. This instrumental arrangement provided data on the lapse rate, the wind velocity, the change of wind velocity, and the wind direction of the stack top.

A photoelectric instrument was designed and built. The instrument was based on the principle of exposure of a

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photoelectric cell to a light of fixed intensity between which was drawn the diluted oil-fog; any change of the light intensity caused by oil-fog droplets would vary the current output of the photoelectric cell. The 'photoelectric vapor densitometer' was extremely sensitive, rapid in action, and quite rugged. It was mounted in a truck capable of going over any type of terrain. The air with the diluted oil-fog was drawn continuously through the instrument by suction from the wind-shield wiper. The same type of instrument was used to determine the dilution when the oil-fog did not come to the ground except that the suction was produced by an aspirator device which operated when there was wind. The instrument and wires to the indicating meter on the ground were supported by a small barrage balloon.

Descriptions of testing and conditions are included.

44 Diffusion of Stack Gases in Stable Atmospheres. Morton L. Barad. nd. 1p. AECU-703.

The document is in abstract form; it is reproduced below in its entirety.

Smoke plumes emitted from elevated sources during the version conditions and characterized by negligibly small settling rates remain aloft for many miles over fairly flat terrain. Photographs of oil-fog plumes taken at the Brookhaven National Laboratory are presented to show the nonisotropic character of diffusion during conditions of strong stability.

Since relatively rapid dilution occurs within the first few meters of a stack, the diffusion problem is treated as a two phase problem. The first phase may be termed the adrodynamic phase, the second phase, the meteorological phase.

The classical diffusion equation is re-examined for possible application in the inversion case. If concentrations of the effluent within the first one or two kilometers of the source are desired, it is desirable to treat the source as an area source of finite concentration rather than a point source of infinite concentration.

45 Stack Gas Dilution in Cross Winds by A. F. Rupp, et al., 28p. May 20, 1944. AECD-1811.

Experiments with small stacks discharging into gentle cross winds showed that the cone of stack gas is bent toward the path of the wind and eventually travels along with the wind, further rise of the gas due to its original stack velocity being negligible compared with vertical eddy diffusion of the cloud. The height and distance downstream from the stack where the cloud becomes substantially horizontal is shown to be

$$H = 1.5 \frac{V_s}{V_w} d_s$$

$$J = 1.5 \frac{V_s}{V_w} d_s$$

where H = height, J = distance down stream, d_s = stack diameter, V_s = stack velocity, V_w = wind velocity, and the diameter of the cloud at this point is,

$$d_{CH} = \frac{V_s}{V_w} d_s .$$

These empirical relations are satisfactory for practical calculations.

Use is also made of the Towle and Sherwood eddy diffusion equation for estimating the concentration of a contaminant at points in the horizontal cloud well beyond the curved portion near the stack.

46 Stack Meteorology and Atmospheric Disposal of Radioactive Waste by Norman R. Beers, Nucleonics 4, No. 4, 28-38(1949) Apr.

Stack meteorology and the atmospheric disposal of radioactive waste are discussed with particular reference to the meteorology towers being used in this connection at the Brookhaven National Laboratory. Some of the more important parameters with which the stack meteorologist determines the control regime to be adopted for a particular waste disposal installation are treated and Sutton's expression [Quart. J. Roy. Met. Soc. 73, 426(1947)] for the concentration of pollutant downwind from a continuously emitting point source is discussed. Some oil-fog smoke tests which have been made to provide necessary information are described and some of the problems of meteorological control are noted.

47 Sweeping of Radioactive Gases from a Homogeneous Pile by S. Katcoff. 19p. MDDC-293.

The radioactive fission-product gases produced in a homogeneous pile were blown by a stream of air through a long tube along whose axis was a negatively charged wire. The various gases deposited their solid radioactive daughters upon the wire in a manner proportional to their half-lives. By cutting the wire into sections and analyzing each one for several fission products, the following results were obtained:

(1) an approximate half-life of 33 seconds for Kr^{90};

(2) an accurate half-life of 1.7 seconds for Xe^{141}; and

(3) the fraction of each of the fission-product chains containing a gaseous member that was swept out of the water boiler. This is tabulated.

48 Decontamination of Radioactive Waste Air. I. R. Philip Hammond. nd. 20p. AECD-2711.

Contaminated waste air has been treated with a baffle-plate scrubbing tower with 42 plates in three stages. The air was sampled for activity before and after each stage and the effect of several process variables investigated. With only 6 plates per stage in use, the efficiency for plain cold water washing was 99.6% or better, and was 99.92% for the "cloud chamber" mode of operation which utilized fogging on radioactive particles to increase the size. Some data on particle size and preliminary engineering figures are given.

49 Removal of Radioactive Particles From Gases by the Trion Electrostatic Precipitator by T. F. Furlong, H. C. Harrison, J. F. O'Donnell, R. P. Webb. MIT Engineering Practice School, Carbide & Carbon Chemical Corporation X-10 Plant, June 23, 1950. 27p. K-615.

Operational tests were made on a Trion electrostatic precipitator to determine its effectiveness in removing radioactive dusts from cell vent gases and its activity building characteristics. The effects of flow rate variation on decontamination and pressure drop and the activity of the unit describing buildings and warehouses were determined. The Trion unit has a decontamination efficiency of 93% when operation at 840 CFM of cell vent gases.

END OF DOCUMENT

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